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U. S. FOREST SERVICE
REGION 6

EVALUATION OF BALSAM WOOLLY APHID ON THE WALLA WALLA RANGER DISTRICT, UMATILLA NATIONAL FOREST

1974

By

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Division of State and Private
Forest Pest Control

INTRODUCTION

The balsam woolly aphid, *Adelges piceae* Ratz., was first detected in northeastern Oregon in a small grove of subalpine fir, *Abies lasiocarpa* (Hook.) Nutt., near the headwaters of Tiger Creek, T6N, R38E., Section 1, in May of 1974 by Mr. Thomas F. Gregg, USFS, Portland. After the specimens were confirmed by Mr. Russel Mitchell, USFS, Corvallis, this find was reported in the Oregon State Federal-State Cooperative Economic Insect Report for the week of September 9-13, 1974.

Prior to this sighting, this insect had never been found farther east of the Cascade Crest than Tumalo Falls, west of Bend, Oregon and Simco Ridge on the Yakima Indian Reservation in Washington State.

On October 2 and 3, 1974, a detection survey was made in high elevation mixed stands on the Walla Walla Ranger District, Umatilla National Forest in Oregon to obtain information concerning the distribution and damage potential of this insect.

Personnel involved in this survey included Bill Carter, Supervisor's Office, Umatilla National Forest; LeRoy Kline and Paul Joseph, Insect and Disease Control, Oregon State Department of Forestry; Dr. Russel Mitchell, Insect Ecologist, Pacific Northwest Forest and Range Experiment Station, Corvallis, Oregon; and Don Curtis and Tom Gregg, Forest Insect and Disease Control, U. S. Forest Service, Portland, Oregon.

The survey, consisting primarily of a visual search of individual subalpine fir trees at systematically selected locations along the Kendall Skyline road system at elevations above 4,000 feet, included examination of about 1,000 trees at 23 locations extending along nearly 25 miles of road system in T. 4-5-6 N., R. 38-39 E.

Positive determination of aphid populations was achieved by visual examination of the lower bole surface of individual trees for spots of white, woolly wax, a conspicuous body covering of this aphid.

Population densities of 20 or more aphids per square inch appear as a whitish, cottony film on the bark; whereas, individual aphids appear as small spots of cotton.

No attempt was made to determine population levels and no foliage samples were examined to determine if twig infestations existed on trees which did not have visible bole infestations. However, one tree was felled to obtain information concerning the effect and duration of stem infestations on trees at the discovery site near Tiger Creek.

This sucking insect, an introduced pest in the Pacific Northwest, has demonstrated considerable ability to weaken and kill three species of true firs in Oregon and Washington.

Infested stands of subalpine fir, *A. lasiocarpa* (Hook.) Nutt. and Pacific silver fir, *A. amabilis* (Dougl.) Forbes, have sustained varying amounts of mortality throughout much of the Cascade Range from the middle fork of the Snoqualmie River in Washington south to Crater Lake National Park in Oregon. In the lowland valleys grand fir, *A. grandis* (Dougl.) Lind., has been damaged and killed throughout the Puget Sound basin in Washington and in western Oregon from Astoria south to the Coquille River drainage (See map 1). Grand fir growing along the crest and on the eastern slopes of the Cascade Range has been commonly infested, but seldom suffers more than superficial gouting (Mitchell 1966).

TECHNICAL INFORMATION

Causal Agent: Balsam woolly aphid, *Adelges piceae* (Ratz.), Homoptera

Host Tree: Subalpine fir, *Abies lasiocarpa* (Hook.) Nutt.

Type of Damage: Occasional light to moderate gouting caused by twig feeding and abnormal tissue along portions of the annual rings caused by stem populations feeding on bark cortex.

Biological Data: No information is available at this time concerning the kind, degree, or the effectiveness of parasites or predators. However, it is doubtful there are any of these agents present since the aphid is an introduced insect from Europe.

Environmental Factors: In North America the life stages consist of eggs, three nymphal instars, and wingless female adults. After emergence, the first instar nymphs move up the tree trunk before finding feeding sites on the bole or within the crown. This "crawler" stage is the only motile period in the insect's life and provides the primary means by which disposal is accomplished within a given tree. Dispersal between trees and stands is accomplished primarily by wind-borne crawlers. The remaining two instars and the adult female stage is spent attached to the tree by feeding stylets inserted into the bark cortex. Reproduction, by parthenogenesis

(egg laying by unmated females), is regulated by the accumulation of heat measured in degree-days above a threshold of 42°F. In the maritime forests of the Pacific Northwest there are usually four generations in lowland valleys, three generations at intermediate elevations, and two generations at high elevations (Mitchell et. al. 1961).

The minimum accumulated heat in degree-days above a threshold of 42°F. required to complete one, two, and three generations, as calculated from Canadian field development data is: 650; 2,200; and 3,800 degree-days, respectively (Greenbank 1970).

An appraisal of the threat posed by the balsam woolly aphid, such as the one used in British Columbia (Atkins 1967), includes a consideration of pest biology, climate, methods of despersal, character of host stands, and geography. However, it has been observed and demonstrated that the major factor limiting the activity of this pest within the range of susceptible host type is local climate (Mitchell et. al. 1961) (Greenbank 1970).

As a general rule the areas of highest aphid hazard and accompanying damage have long growing seasons, a high summation of heat above the insect's development threshold, and normally mild winters. Conversely, low hazard areas have short growing seasons, low accumulation of summer heat, and a high frequency of severe winter temperatures.

The distribution and abundance of this insect are strongly regulated by winter temperatures. Only the first instar larvae is cold-hardy. All other stages are killed by exposure to temperatures lower than 0°F. In addition, temperatures below -32°F. kill more than 90 percent of all overwintering nymphs not insulated by snow cover; and all exposed stages are killed by temperatures of -35°F. or lower (Greenbank 1970).

Subalpine fir, the most sensitive of the three susceptible host species, is often killed within 3 years following stem infestation. In some stands in the Cascades, 90 percent of the subalpine firs have been killed within 5 years, mostly by stem infestations. Mortality resulting solely from gouting-type crown attacks is insignificant (Mitchell 1966).

Noble fir, *A. procera* Rehd., Shasta red fir, *A. magnifica* var. *shastensis* Lemm., and white fir, *A. concolor* (Gord. and Glend.) Lindl., have demonstrated resistance to the aphid when growing in natural stands. However, when grown as ornamentals or as arboretum specimens out of their natural environment these species have been damaged and even killed by this pest.

The most susceptible stands appear to be those on the best sites--stream bottoms, benches, and along meadows. In addition, the greatest damage occurs at the lowest elevational limits of the host species--approximately 3,000 feet in the Cascades. Subalpine fir growing in mixture with Engelmann spruce, *Picea engelmannii* Parry, on boggy sites is especially vulnerable to attack in the Cascades. Open stands on old lava beds or slide areas, which have been pioneered by subalpine fir, are also commonly infested.

The least susceptible stands are those on low-site hillsides and at high elevations, near timberline. Infestations are rarely found on trees at elevations above 5,000 feet (Mitchell 1966).

The damage, caused by localized chemical reaction between the feeding aphid and its host, consists of both an abnormal production of phloem and ray cells and a noticeable swelling of twigs and terminals often referred to as "gouting."

The gouting, a symptom of woolly aphid attack shared by all North American species of *Abies*, appears as a stunting of terminal growth with distinct swellings around the buds and branch nodes. The largest "gouts" occur in the fastest growing parts of the crown and on trees that have been lightly infested for a long time. Trees with this type of injury decline slowly, often persisting for many years. Bud growth is inhibited and the resulting scarcity of new foliage brings about gradual starvation, causing the tree to die slowly from the top down (Mitchell et. al. 1970).

Mass infestation along the main stem, which causes an abnormally thick annual ring, usually results in the rapid death of a susceptible species. Death being caused primarily by disruption of water movement through the tree. Symptoms of decline vary somewhat with the tree species infested, but generally the foliage in a dying tree turns yellow, then deep red or brown. This sequence is particularly characteristic of infested subalpine fir in the Cascade Range. Stem-infested grand and Pacific silver firs generally show needle loss, followed by a change in color to a grayish-green and, ultimately, death.

SURVEY RESULTS

The results of our survey indicate that the balsam woolly aphid is now lightly infesting subalpine fir in the headwaters of the north and south forks of the Walla Walla River.

The extent of infestation is not well defined at this time. However, aphid populations were found on 30 trees at six of the 23 sampling locations along the Skyline Road. These spot infestations were observed in T. 5N. R.38E. Sections 1, 11, 12 and 13 and in T. 5N. R.39E. Sections 4 and 5 (See map 2).

No tree mortality, top-killing, or discolored crown foliage normally associated with aphid feeding was observed. In addition, no evidence of aphid populations or damage caused by aphid feeding was observed on any grand fir in the vicinity of infested subalpine fir.

Bole dissection of one 10" DBH tree at Tiger Creek indicates that aphid populations have been at that location since 1967. The lower bole of the tree was heavily infested and the entire crown contained visible nodal swellings. Abnormal tissue, resembling compression wood, was visible along portions of the past seven growth rings on each of the three discs taken at 6', 12' and 18' along the bole of this 24' tree.

Visual examination of the remaining 17 trees within this grove revealed that they had all experienced some degree of stem infestation and/or twig gouting over the past several years.

Suppressed and intermediate trees which have been severely damaged are now showing limited signs of bud recovery. However, it is doubtful if many of these trees will fully recover.

DISCUSSION

Because 7 years of continuous infestation has caused no mortality and resulted in only limited visible top damage to some subalpine fir trees, no significant long-term economic impact is expected. At the present time the tree has limited value as a timber species and is currently being managed primarily for recreation.

However, if grand fir, an important commercial species, were to become infested and damaged to the same degree as has occurred on the west side of the Cascade Mountains, serious economic impact could result.

The results of our survey did not reveal any aphid feeding on grand fir. However, feeding preference and potential for damage will be more fully explored in future studies and surveys.

In the meantime, it is safe to assume that the existing aphid populations will remain active and that dispersal will continue. Eventually much of the subalpine fir type in the Blue Mountains below the 5,500' elevation is expected to become infested.

A brief review of climatological data from reporting stations at Dayton, Pomeroy, and Walla Walla in Washington, and Milton-Freewater and Meacham in Oregon indicate that the climate of this portion of the Blue Mountains is somewhat transitional between the high hazard maritime and the low hazard continental climates.

Minimum temperatures of 0^{o}F. or lower have occurred at these five weather stations during 5 of the last 10 winters. Temperatures of -20^{o}F. or lower have been recorded only 2 of the last 10 winters at Meacham and only once at Dayton, Pomeroy and Milton-Freewater.

The following is a listing by year of the lowest temperatures recorded at each of the five stations for the period 1964-1973:

Reporting Station	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Dayton	-11	12	16	6	-25	-9	8	10	-11	-7
Pomeroy	-17	--	13	4	-27	-6	7	10	-11	-6
Walla Walla	-16	10	7	7	-18	-5	10	8	-8	-4
Milton-Freewater	-9	13	18	5	-24	-8	10	7	-15	-11
Meacham	-22	1	7	2	-20	-4	7	2	-16	-8

Local meteorological data indicates that portions of the Blue Mountains supporting subalpine fir below 5,000' elevation accumulates approximately 2,500 degree-days per year and while the cooler areas above 5,000' elevation, total only 1,000-1,500 degree-days. This indicates that an average 1 to 1 1/2 generations may be completed in the areas above 4,500' where subalpine fir dominates.

The effect of weather in limiting both population density and rate of development may explain why both the observed damage patterns and rate of spread appears to be different than those recorded for stands in the Cascades.

Additional factors which suggest a slow rate of spread include the mixed nature of the stands, the irregular destruction of pure subalpine fir type, and the north-south terrain barriers which effect wind patterns.

However, dispersal could be enhanced by the transporting of aphids from infested areas on firewood brought by campers or hunters; on clothing or pack gear of forest recreationists; and possibly on logging equipment brought from other infested areas for use in harvesting timber.

Accidental transport probably accounts for the existence of this pest in the Blue Mountains and will very likely provide for future dispersal into areas that would otherwise be safe from natural invasion.

RECOMMENDATIONS

Because of the limited knowledge concerning the balsam woolly aphid in the Blue Mountains, it is recommended that the following measures be taken:

1. Conduct additional surveys to more fully determine the distribution of this insect in the Blue Mountains.

2. Establish trend and impact plots on a cooperative basis with PNW research personnel to more fully evaluate the population dynamics of this insect in the Blue Mountains and determine its potential for causing damage.

3. Minimize dispersal from infested areas above 4,000' elevation within the Walla Walla Ranger District, Umatilla National Forest by:

   a. selective logging of infested stands

   b. cleaning logging equipment used in infested areas with high pressure water hose before moving into uninfested susceptible type.

   c. periodically checking recreational sites (both developed and hunter camps) to determine if aphids are being dispersed by accidental transport.

   d. cleanup logging areas by destroying all residual infested trees.

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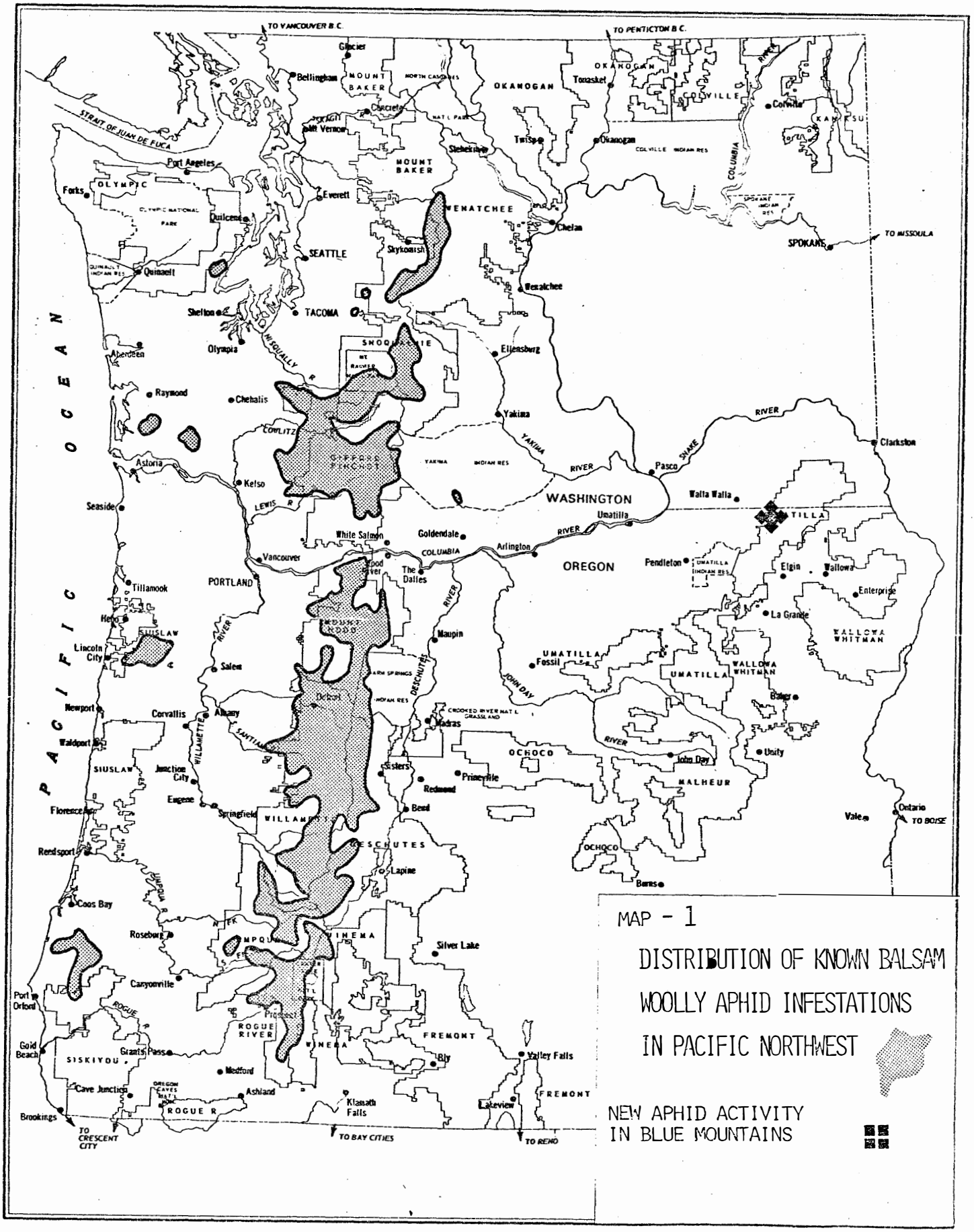
Attachments: Maps 1 and 2

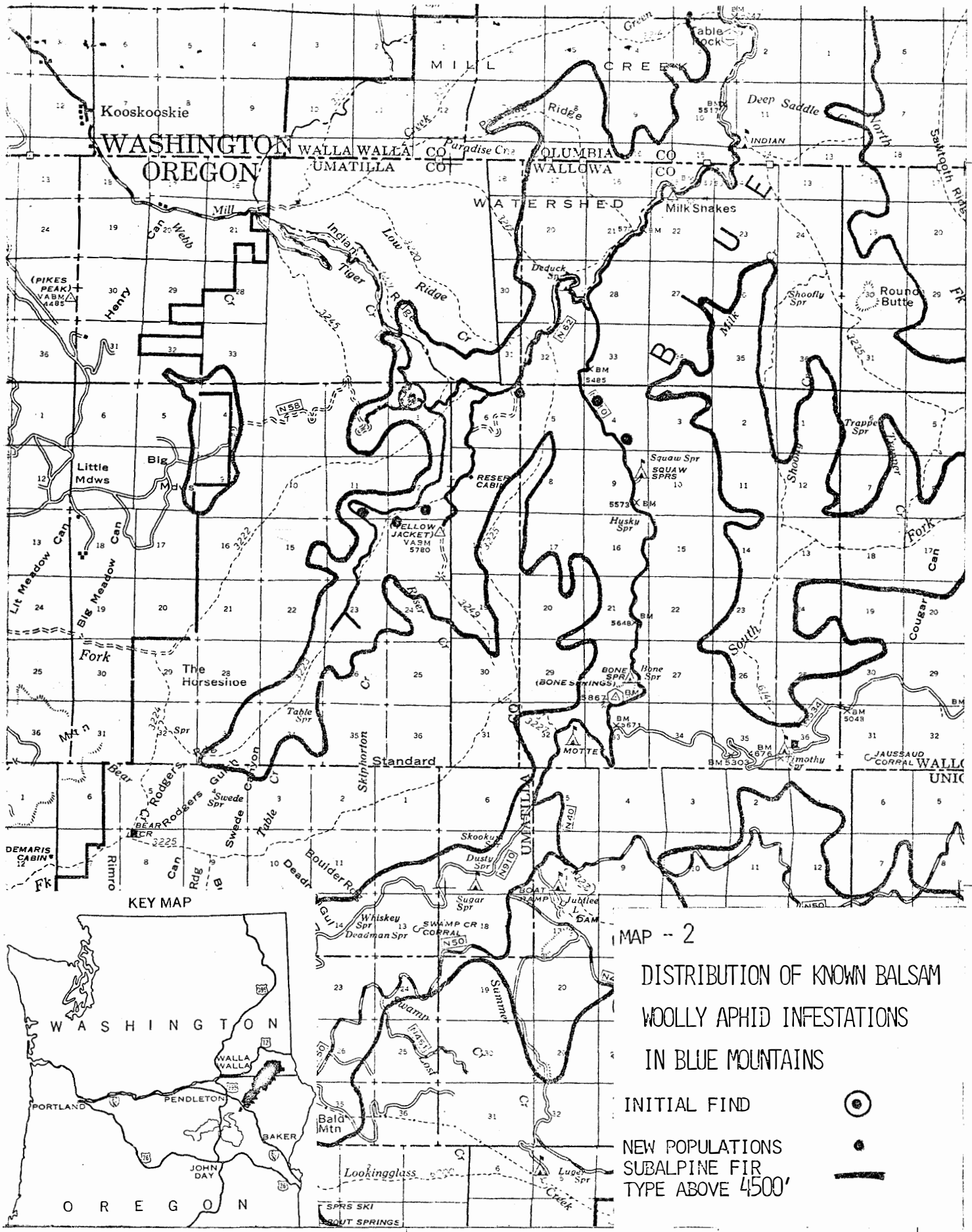
cc: W.O.
Regions 1,2,3,4 & 5
PNW
PSW
INT
RM
Walla Walla RD
Umatilla NF
OSDF - LeRoy Kline & Paul Joseph



MAP - 1

DISTRIBUTION OF KNOWN BALSAM WOOLLY APHID INFESTATIONS IN PACIFIC NORTHWEST

NEW APHID ACTIVITY IN BLUE MOUNTAINS



MAP - 2

DISTRIBUTION OF KNOWN BALSAM WOOLLY APHID INFESTATIONS IN BLUE MOUNTAINS

INITIAL FIND

NEW POPULATIONS

SUBALPINE FIR TYPE ABOVE 4500'

BMNR 344.1

RMR 1437

Dickerson et al.

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Region 6
P.O.Box 3623, Portland, Oregon 97208

REPLY TO: 5230 Evaluation

March 25, 1975

SUBJECT: Evaluation of Balsam Woolly Aphid on the Walla Walla Ranger District, Umatilla National Forest

TO: Forest Supervisor, Umatilla National Forest

Enclosed are two copies of Donald J. Curtis's and Tommy F. Gregg's evaluation of the balsam woolly aphid in the Walla Walla Ranger District on the Umatilla National Forest.

This report describes the first sighting of the balsam woolly aphid populations in the Blue Mountains in northeastern Oregon.

David A. Graham

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Director, Insect and Disease Control

Enclosures

PNW EXP STATION
APR 11 1975
RECEIVED